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# Age and gender differences in health-related quality of life of children and adolescents in Europe: a multilevel analysis

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**Abstract**
*Objectives* To determine age and gender differences in health-related quality of life (HRQOL) in children and adolescents across 12 European countries using a newly developed HRQOL measure (KIDSCREEN).
*Methods* The KIDSCREEN-52 questionnaire was filled in by 21,590 children and adolescents aged 8–18 from 12 countries. We used multilevel regression analyses to model the hierarchical structure of the data. In addition, effect sizes were computed to test for gender differences within each age group.
*Results* Children generally showed better HRQOL than adolescents ($P < 0.001$). While boys and girls had similar HRQOL at young age, girls' HRQOL declined more than boys' ($P < 0.001$) with increasing age, depending on the HRQOL scale. There was significant variation between countries both at the youngest age and for age trajectories.
*Conclusions* For the first time, gender and age differences in children's and adolescents' HRQOL across Europe were assessed using a comprehensive and standardised instrument. Gender and age differences exist for most HRQOL scales. Differences in HRQOL across Europe point to the importance of national contexts for youth's well-being.

**Keywords** Quality of life · Child · Adolescent · Sex characteristics · Europe

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**Abbreviations**

| | |
|---|---|
| AT | Austria |
| CH | Switzerland |
| CZ | Czech Republic |
| DE | Germany |
| EL | Greece |
| ES | Spain |
| FR | France |
| HU | Hungary |
| HRQOL | Health-related quality of life |
| NL | The Netherlands |
| PL | Poland |
| SE | Sweden |
| UK | United Kingdom |
| UNICEF | United Nations International Children's Emergency Fund |
| WHO | World Health Organisation |

## Introduction

In recent years, health-related quality of life (HRQOL) aroused the interest of the public health community as a relevant health outcome complementing somatic measures such as morbidity and mortality. HRQOL as a multidimensional measure can be defined as an individual's satisfaction or happiness in various life domains that affect or are affected by health [1]. The measurement of HRQOL in child and adolescent populations was for a long time underinvestigated in comparison with adults HRQOL. However, to detect impairments of well-being and functioning, it is essential to assess how children and adolescents perceive their own situation.

Population studies report gender differences in subjective health and HRQOL in childhood, adolescence, and adulthood [2–5]. However, we do not know whether findings are comparable across different countries and cultures. The European Commission's report on the health of adolescents published in 2000 supports findings of gender differences and specifies a "shift in gender-related health status between childhood and adolescence" [6, p. 17]. Moreover, studies suggest that female adolescents have a poorer perception of their own health and report a higher presence and frequency of somatic symptoms than boys [3]. Those patterns could also be observed cross-nationally in a study including 29 European and North American countries [7]. Findings showed increasing gender differences across adolescents' age such that older girls were at increased risk for health complaints across all included countries. Another study on self-reported problems of 11–18-year-old youths from seven different countries [8] also demonstrated cross-national similarities in gender differences with girls scoring higher than boys on total problems and internalizing scales, whereas boys scored higher than girls on the externalizing scales. Consistent with prior studies, girls also showed a poorer HRQOL status than boys [2, 9, 10]. However, comparability between those studies is rather restricted as measurement of HRQOL differs and studies fail to capture the multidimensional aspects of HRQOL [11].

Research specifically assessing age differences in children's and adolescents' HRQOL is rare, although some studies suggest that children's HRQOL is mostly higher than those of adolescents' [10, 12]. Those findings go in line with the study of the WHO on health behaviour in school-aged children (HBSC). The authors [3] analysed HBSC data on more than 160,000 children and adolescents from 29 European countries, North America, and Israel. Results indicate that adolescents are in a worse position than children regarding reported symptoms and perception of health. In general, a majority of cultures showed more symptoms and lower health perception on most HRQOL scales with increasing age. This is comparable to the results reported by the European Commission [6]. A recent cross-sectional study on life satisfaction in German adolescents showed lower satisfaction in girls with a decrease in satisfaction for both genders from age 11 to 16 years [13]. However, another recent longitudinal study in England found a decrease only in physical health but not other HRQOL aspects in a cohort of adolescents over the course of 1 year [14].

The Centers for Disease Control and Prevention [15] explicitly recommends the identification of subgroups of children and adolescents who are at risk for health problems with suitable HRQOL measures. A substantial number of generic and disease-specific self-report measures to detect HRQOL for younger respondents exist these days, and they are still rapidly growing in number [16, 17]. The European KIDSCREEN group, funded in 2001 by the European Commission, was the first research group to develop a cross-cultural, standardised HRQOL-screening instrument for 8 to 18-year-old children and adolescents in the general population [18–20]. HRQOL is defined as a multidimensional construct, and 10 specific aspects of HRQOL are measured. They broadly encompass physical, psychological, and social components of well-being in line with the definition of the World Health Organisation [21]. Moreover, the questionnaire is applicable in both healthy and ill populations.

The aim of the present study was to examine gender and age differences, differences between countries in general HRQOL, and 10 specific HRQOL aspects in a large international sample of 8–18-year-old children and adolescents from 12 European countries. We used multilevel regression modelling allowing direct comparison of children and adolescents in different countries rather than within-country comparisons as in previous studies [13, 14]. In contrast to previous studies that only analysed gender differences for a few specific age groups, we included children and adolescents from all ages between 8 and 18 years [3]. Using multilevel regression modelling in this cross-sectional dataset thus allowed a more detailed insight into the development of children's and adolescents' HRQOL. We expected age and gender differences in HRQOL across countries. We assumed that adolescents, especially girls, show lower values in HRQOL than children. Specific assumptions concerning gender and age differences for each HRQOL aspect have been formulated and are based on the pilot study having taken place in 2002, when seven European countries had been investigated [2]. For some scales, we had no specific hypotheses because of a lack of plausible assumptions in the literature and expert opinions. Hypotheses concerning age and gender effects on general HRQOL and the 10 more specific HRQOL scales are presented in Table 1. We had no specific hypothesis about differences between countries in their children's and adolescents' HRQOL.

## Methods

### Participants and sampling

The study surveyed a sample of 21,590 children and adolescents from 12 European countries who participated in the KIDSCREEN study in 2003 (http://www.kidscreen.org) and completed a questionnaire on their health and HRQOL. The following countries were included: Austria (AT), Switzerland (CH), Czech Republic (CZ), Germany (DE), Greece (EL), Spain (ES), France (FR), Hungary (HU), the

**Table 1** Hypotheses concerning age and gender effects on general HRQOL and the 10 specific HRQOL aspects (KIDSCREEN scales)

| KIDSCREEN scales and definitions | Hypotheses concerning gender[a] | Results concerning gender | Hypotheses concerning age | Results concerning age |
|---|---|---|---|---|
| **General HRQOL** feeling happy, fit and satisfied with regard to family life, peers, and school life | Higher values for male adolescents | ✔ | Higher values for children | ✔ |
| **Physical Well-Being ("physical")** explores complaints of poor health, physical activity, energy, and fitness. | Higher values for male adolescents | ✔ | Higher values for children | ✔ |
| **Psychological Well-Being ("psychological")** reveals positive perceptions and emotions | Higher values for male adolescents | ✔ | Higher values for children | ✔ |
| **Moods and Emotions ("mood")** covers depressive moods, emotions, and stressful feelings | Higher values for male adolescents | ✔ | Higher values for children | ✔ |
| **Self-Perception ("self")** includes views about one's physical appearance and the person | Higher values for male adolescents | ✔ | Higher values for children | ✔ |
| **Autonomy ("autonomy")** examines the autonomy and opportunity to shape one's social and leisure time | No hypothesis | *Higher values for male adolescents* | No hypothesis | *Higher values for children* |
| **Parent Relations and Home Life ("parents")** explores the quality of the interaction with parents or guardians | No hypothesis | *Higher values for male adolescents* | Higher values for children | ✔ |
| **Peers and Social Support ("peers")** examines social relations with friends and peers | No hypothesis | *Higher values for female children/adolescents* | No hypothesis | *Higher values for children* |
| **School Environment ("school")** explores the perception of the cognitive capacity, learning, and concentration | No differences between female and male adolescents | ✔*—higher values for female children* | Higher values for children | ✔ |
| **Social Acceptance/Bullying ("bullying")** investigates the feeling of being rejected and anxiety towards peers | No hypothesis | *Higher values for female adolescents* | Higher values for adolescents | ✔ |
| **Financial Resources ("financial")** reflects whether the child/adolescent feels that he/she has enough financial resources to live like other children/adolescents | No hypothesis | *Higher values for female children and male adolescents* | No hypothesis | *Higher values for male children than male adolescents* |

[a] Hypothesis regarding gender (tested by the interaction effect $\beta_3$) takes age into account as assumptions cannot be hypothesised independently of age

Netherlands (NL), Poland (PL), Sweden (SE), and United Kingdom (UK). The study used a cross-sectional design. Different approaches for sample selection were used across countries in order to obtain random samples. AT, CH, DE, ES, FR, and NL implemented a telephone sampling with random-digital dialling in order to identify households with respondents in the desired age range. If the parent agreed to participate in the study, questionnaires were mailed to their home address. Telephone sampling in addition to school sampling with survey administration during class time was carried out by EL, HU, PL, SE, and the UK, where schools have been randomly selected in each administrative region. Multistage random sampling of communities and households was realised by the CZ: communities were randomly selected across the country, out of which households were finally chosen using a telephone directory. Ethical approval was received from national or local ethics committees in every country. A more detailed description of the KIDSCREEN sampling methods is provided elsewhere, together with a detailed analysis of its representativeness based on Eurostat data [22].

## Measures

The KIDSCREEN-52 includes 52 items covering 10 aspects in 10 scales, i.e. physical (physical well-being), psychological (psychological well-being, moods and emotions, self-perception), and social components (autonomy, parent relations and home life, peers and social support, school environment, social acceptance/bullying, and financial resources) of HRQOL in children and adolescents aged between 8 and 18. Between 3 and 7 items operationalising each aspect had to be rated on a 5-point scale (ranging from "not at all" to "extremely" or from "never" to "always"). Certain items were recoded such that higher values indicate better QOL in all scales. The sum scores for each scale were transformed to a T-value with a mean = 50 and standard deviation = 10. Out of the KIDSCREEN-52 list, an additional general HRQOL index can be computed through selection of 10 items, providing an overall index of HRQOL. This general index correlates highly with the following scales "physical well-being", "psychological well-being", "moods and emotions", "autonomy", "parent relations and home life", and "school environment". It has been shown that the instrument has satisfactory reliability and validity and good internal consistency [19, 20, 23].

## Statistical analyses

In order to take the hierarchical structure of the dataset into account, a multilevel modelling approach was used. Level 1 included individuals (children and adolescents), and level 2 included countries. Using a multilevel approach, we were able to analyse the variation in average QOL between individuals within a country and between countries. Including random variation on level 2 (countries) allowed for possible similarities of children and adolescents living in the same country and, therefore experiencing a potentially similar socio-economic and cultural background, while at the same time accounting for differences between countries. Another advantage of multilevel modelling is that datasets do not need to be equally balanced for each level 2 unit (country). Even if certain information is missing for some countries, all information available for each country is included (in our dataset, for example, there is no information available about 8–11 and 16–18-year-old children and adolescents from Sweden).

Statistical analyses were conducted with *MLwiN* 1.10 for Windows [24]. Gender, age, and interaction between gender and age were put in the model as fixed effects. We decided to model age as a linear effect (quadratic and cubic effects did not change the results). Random effects were included for the intercept on the country level and the individual level, as well as for age at the country level. Random effects on the country level had been tested for gender, though no random effects could be detected. Results are thus presented without their inclusion in the model. The following model specifications were used for each scale.

$$\begin{aligned} \text{Scale-score}_{ij} &= \beta_{0ij} + \beta_1 \text{Gender}_{ij} + \beta_{2j} \text{Age}_{ij} \\ &\quad + \beta_3 \text{Gender}_{ij} \times \text{Age}_{ij} \\ \beta_{0ij} &= \beta_0 + u_{0j} + e_{0ij} \\ \beta_{2ij} &= \beta_2 + u_{2j} \end{aligned}$$

In our study, the intercept $\beta_0$ indicates the reference group and represents the average score for a boy aged 8. Gender ($\beta_1$) can be interpreted as the difference in the average score between girls when compared to boys at the age of 8 years. The age effect ($\beta_2$) is the change of the score for each additional year of age for boys. Interaction effect ($\beta_3$) represents the difference in the change of the score for each additional year of age for girls when compared to boys. The random effects on the country level allowed countries to differ in their children's average score of quality of life ($u_{0j}$) as well as in the average change per year of age ($u_{2j}$). The lower level random effect ($e_{0ij}$) represents the variance between individuals within a country in their average score.

In order to test for differences between genders within each year of age, effect sizes $d$ (mean difference divided by the shared standard deviation) have been computed for each HRQOL scale. To report a meaningful difference on the HRQOL values between the genders, a small effect size ($d > 0.2$) had to be detected.

**Table 2** Age and gender characteristics of samples across European countries ($N = 21,590$)

| | AT | CH | CZ | DE | EL | ES | FR | HU | NL | PL | SE | UK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age in years | | | | | | | | | | | | |
| Mean | 12.95 | 12.82 | 12.94 | 13.04 | 12.90 | 14.62 | 12.91 | 12.68 | 12.43 | 12.81 | 13.16 | 13.66 | 11.74 |
| SD | 2.69 | 2.82 | 2.71 | 3.02 | 2.85 | 1.68 | 2.91 | 2.93 | 2.99 | 2.88 | 2.79 | 0.99 | 2.68 |
| Range | 8–18 | 8–18 | 8–18 | 8–18 | 8–18 | 11–18 | 8–18 | 8–18 | 8–18 | 8–18 | 8–18 | 12–15 | 8–18 |
| Gender | | | | | | | | | | | | | |
| Male (%) | 10,225 (47.4) | 682 (46.2) | 789 (46.4) | 804 (50.5) | 839 (48.7) | 475 (40.4) | 446 (50.9) | 505 (48.1) | 1,347 (41.6) | 921 (48.9) | 776 (45.2) | 1,674 (51.0) | 967 (51.5) |
| Female (%) | 11,365 (52.6) | 793 (53.8) | 912 (53.6) | 788 (49.5) | 884 (51.3) | 702 (59.6) | 430 (49.1) | 544 (51.9) | 1,890 (58.4) | 964 (51.1) | 939 (54.8) | 1,609 (49.0) | 910 (48.5) |
| Total (%) | 21,590 (100) | 1,475 (6.8) | 1,701 (7.9) | 1,592 (7.4) | 1,723 (8.0) | 1,177 (5.5) | 876 (4.1) | 1,049 (4.9) | 3,237 (15.0) | 1,885 (8.7) | 1,715 (7.9) | 3,283 (15.2) | 1,877 (8.7) |

*AT* Austria, *CH* Switzerland, *CZ* Czech Republic, *DE* Germany, *EL* Greece, *ES* Spain, *FR* France, *HU* Hungary, *NL* The Netherlands, *PL* Poland, *SE* Sweden, and *UK* United Kingdom

## Results

The total sample included 21,590 children and adolescents (47.4% male). Age and gender characteristics were similar across all countries (Table 2). Response rates varied across countries between 24 and 91% [22].

General HRQOL represents the typical trajectory for the change of HRQOL between ages 8 and 18 years in boys and girls. Boys and girls aged 8 had a similar average score, and the score was decreasing continually for boys and girls of older age. At age 18, scores for boys were higher than that for girls (see also Table 3 and Fig. 1 with the average scale scores by gender). Compared with the typical trajectory of general HRQOL, a similar pattern of trajectories was found for the "physical", "psychological", "mood", "self", "autonomy", and "parent's" scales. A slight difference could be seen in the "physical well-being" (−0.84 points) and the "self-perception" (−1.67 points) scales, where girls aged 8 had on average a significantly lower HRQOL than boys of the same age. While the score was decreasing with every age step in both genders, it was decreasing more in girls than in boys. This more pronounced decrease in girls was also found in all other scales apart from "peers", where the decrease in girls and boys did not differ, and for "bullying", where girls had a more pronounced increase than boys.

Regarding "parent relations and home life", girls aged 8 had on average significantly higher scores (0.77 points) than boys of the same age, and their trajectory decreased faster than boys'. Similarly, girls at age 8 also had a significant higher average score in "peers and social support", "school environment", and "financial resources". But apart from the scale "peers and social support", where 18-year-old girls also had a higher score, the more pronounced decrease in girls' average score let the trajectory end up similarly as ("school") or even lower than ("parents") boys' at the age of 18 years.

Regarding age differences, the two scales "financial resources" and "social acceptance/bullying" stand out because of an inverted effect. The average score increased with age for both genders in "social acceptance/bullying" and only for the boys in "financial resources".

The level 2 random effects for the intercept showed significant effects in all scales such that the average scores for each scale varied significantly from country to country. In addition, there was also significant variation in the influence of age for all scales but bullying and financial. Random effects on level 1 showed that there is significant variation between children within each country for all scales.

A meaningful difference between genders could be detected from ages 13 or 14 years onwards in the general HRQOL scale as well as in the "moods" and "psychological" scales with $d$ ranging from 0.25 to 0.53. An earlier

**Table 3** Multilevel regression results: fixed and random effects of HRQOL scales ($N = 21{,}590$)

| Fixed effects | General HRQOL | | | | Physical | | | |
|---|---|---|---|---|---|---|---|---|
| | $\beta$ | 95% CI | $\chi^2$ | $P$ | $\beta$ | 95% CI | $\chi^2$ | $P$ |
| Intercept $\beta_0$ | 56.220 | 54.113 to 58.327 | 2736.6 | <0.001 | 56.360 | 54.819 to 57.901 | 5136.6 | <0.001 |
| Female $\beta_1$ | 0.234 | −0.287 to 0.754 | 0.8 | 0.379 | −0.843 | −1.365 to −0.320 | 10.0 | 0.002 |
| Age (increase per year) $\beta_2$ | −1.030 | −1.251 to −0.809 | 83.2 | <0.001 | −0.889 | −1.058 to −0.721 | 107.3 | <0.001 |
| Age × gender interaction $\beta_3$ | −0.411 | −0.504 to −0.318 | 75.4 | <0.001 | −0.417 | −0.510 to −0.324 | 77.1 | <0.001 |
| Random effects | Estimate | SE | $\chi^2$ | $P$ | Estimate | SE | $\chi^2$ | $P$ |
| Level 2: intercept $u_{0j}$ | 13.290 | 5.560 | 5.7 | 0.017 | 6.861 | 2.934 | 5.5 | 0.019 |
| Level 2: age $u_{2j}$ | 0.136 | 0.059 | 5.2 | 0.022 | 0.071 | 0.033 | 4.7 | 0.030 |
| Level 1: intercept $e_{0ij}$ | 81.460 | 0.803 | 10296.5 | <0.001 | 84.240 | 0.821 | 10518.0 | <0.001 |
| | −2*log(lh) is 149319 | | | | −2*log(lh) is 153220 | | | |
| Fixed effects | Psychological | | | | Mood | | | |
| | $\beta$ | 95% CI | $\chi^2$ | $P$ | $\beta$ | 95% CI | $\chi^2$ | $P$ |
| Intercept $\beta_0$ | 55.130 | 53.345 to –56.915 | 3664.5 | <0.001 | 54.380 | 52.703 to 56.057 | 4038.4 | <0.001 |
| Female $\beta_1$ | 0.427 | −0.095 to 0.949 | 2.6 | 0.109 | −0.039 | −0.581 to 0.502 | 0.0 | 0.888 |
| Age (increase per year) $\beta_2$ | −0.867 | −1.080 to −0.653 | 63.1 | <0.001 | −0.555 | −0.752 to −0.358 | 30.4 | <0.001 |
| Age × gender interaction $\beta_3$ | −0.303 | −0.396 to −0.210 | 40.8 | <0.001 | −0.484 | −0.580 to −0.387 | 97.1 | <0.001 |
| Random effects | Estimate | SE | $\chi^2$ | $P$ | Estimate | SE | $\chi^2$ | $P$ |
| Level 2: intercept $u_{0j}$ | 9.387 | 3.966 | 5.6 | 0.018 | 8.181 | 3.482 | 5.5 | 0.019 |
| Level 2: age $u_{2j}$ | 0.125 | 0.055 | 5.2 | 0.023 | 0.103 | 0.046 | 5.0 | 0.026 |
| Level 1: intercept $e_{0ij}$ | 84.830 | 0.823 | 10627.1 | <0.001 | 90.430 | 0.879 | 10576.6 | <0.001 |
| | −2*log(lh) is 154967 | | | | −2*log(lh) is 155569 | | | |
| Fixed effects | Self | | | | Autonomy | | | |
| | $\beta$ | 95% CI | $\chi^2$ | $P$ | $\beta$ | 95% CI | $\chi^2$ | $P$ |
| Intercept $\beta_0$ | 56.670 | 55.081 to 58.259 | 48884.8 | <0.001 | 53.010 | 51.226 to 54.794 | 3393.5 | <0.001 |
| Female $\beta_1$ | −1.679 | −2.191 to −1.167 | 41.4 | <0.001 | 0.102 | −0.426 to −0.630 | 0.1 | 0.704 |
| Age (increase per year) $\beta_2$ | −0.890 | −1.052 to −0.727 | 115.3 | <0.001 | −0.359 | −0.567 to −0.151 | 11.4 | <0.001 |
| Age × gender interaction $\beta_3$ | −0.532 | −0.623 to −0.441 | 131.4 | <0.001 | −0.432 | −0.526 to −0.338 | 81.4 | <0.001 |
| Random effects | Estimate | SE | $\chi^2$ | $P$ | Estimate | SE | $\chi^2$ | $P$ |
| Level 2: intercept $u_{0j}$ | 7.357 | 3.148 | 5.5 | 0.019 | 9.360 | 3.957 | 5.6 | 0.018 |
| Level 2: age $u_{2j}$ | 0.066 | 0.030 | 4.7 | 0.030 | 0.117 | 0.052 | 5.1 | 0.024 |
| Level 1: intercept $e_{0ij}$ | 81.380 | 0.790 | 10625.9 | <0.001 | 86.750 | 0.841 | 10634.5 | <0.001 |
| | −2*log(lh) is 154047 | | | | −2*log(lh) is 155553 | | | |
| Fixed effects | Parents | | | | Peers | | | |
| | $\beta$ | 95% CI | $\chi^2$ | $P$ | $\beta$ | 95% CI | $\chi^2$ | $P$ |
| Intercept $\beta_0$ | 53.820 | 52.150 to 55.490 | 3987.6 | <0.001 | 50.690 | 49.099 to 52.281 | 3900.4 | <0.001 |
| Female $\beta_1$ | 0.766 | 0.232 to 1.299 | 7.9 | 0.005 | 1.109 | 0.557 to 1.661 | 15.5 | <0.001 |
| Age (increase per year) $\beta_2$ | −0.761 | −0.938 to −0.584 | 71.4 | <0.001 | −0.252 | −0.394 to −0.109 | 11.9 | <0.001 |
| Age × gender interaction $\beta_3$ | −0.269 | −0.364 to −0.173 | 30.7 | <0.001 | −0.031 | −0.130 to −0.067 | 0.4 | 0.529 |

**Table 3** continued

| Random effects | Estimate | SE | $\chi^2$ | *P* | Estimate | SE | $\chi^2$ | *P* |
|---|---|---|---|---|---|---|---|---|
| Level 2: intercept $u_{0j}$ | 8.130 | 3.451 | 5.6 | 0.018 | 7.294 | 3.117 | 5.5 | 0.019 |
| Level 2: age $u_{2j}$ | 0.079 | 0.036 | 4.8 | 0.029 | 0.045 | 0.022 | 4.1 | 0.044 |
| Level 1: intercept $e_{0ij}$ | 88.140 | 0.858 | 10545.5 | <0.001 | 93.870 | 0.914 | 10538.1 | <0.001 |
| | −2*log(lh) is 154579 | | | | −2*log(lh) is 155793 | | | |

| Fixed effects | School | | | | Bullying | | | |
|---|---|---|---|---|---|---|---|---|
| | $\beta$ | 95% CI | $\chi^2$ | *P* | $\beta$ | 95% CI | $\chi^2$ | *P* |
| Intercept $\beta_0$ | 55.800 | 53.577 to 58.023 | 2420.7 | <0.001 | 47.270 | 45.999 to 48.541 | 5309.4 | <0.001 |
| Female $\beta_1$ | 2.691 | 2.177 to 3.205 | 105.1 | <0.001 | −0.260 | −0.807 to 0.286 | 0.9 | 0.351 |
| Age (increase per year) $\beta_2$ | −1.256 | −1.505 to −1.007 | 97.6 | <0.001 | 0.448 | 0.325 to 0.570 | 51.6 | <0.001 |
| Age × gender interaction $\beta_3$ | −0.309 | −0.400 to −0.217 | 43.4 | <0.001 | 0.129 | 0.032 to 0.227 | 6.7 | 0.009 |

| Random effects | Estimate | SE | $\chi^2$ | *P* | Estimate | SE | $\chi^2$ | *P* |
|---|---|---|---|---|---|---|---|---|
| Level 2: intercept $u_{0j}$ | 14.880 | 6.203 | 5.7 | 0.017 | 4.466 | 1.953 | 5.2 | 0.022 |
| Level 2: age $u_{2j}$ | 0.177 | 0.076 | 5.4 | 0.020 | 0.028 | 0.015 | 3.4 | 0.065 |
| Level 1: intercept $e_{0ij}$ | 81.470 | 0.795 | 10498.5 | <0.001 | 93.410 | 0.906 | 10631.1 | <0.001 |
| | −2*log(lh) is 152245 | | | | −2*log(lh) is 157047 | | | |

| Fixed effects | Financial | | | |
|---|---|---|---|---|
| | $\beta$ | 95% CI | $\chi^2$ | *P* |
| Intercept $\beta_0$ | 49.060 | 46.786 to 51.334 | 1788.4 | <0.001 |
| Female $\beta_1$ | 0.774 | 0.233 to 1.314 | 7.9 | 0.005 |
| Age (increase per year) $\beta_2$ | 0.183 | 0.058 to 0.308 | 8.2 | 0.004 |
| Age × gender interaction $\beta_3$ | −0.204 | −0.300 to −0.109 | 17.5 | <0.001 |

| Random effects | Estimate | SE | $\chi^2$ | *P* |
|---|---|---|---|---|
| Level 2: intercept $u_{0j}$ | 15.580 | 6.485 | 5.8 | 0.016 |
| Level 2: age $u_{2j}$ | 0.031 | 0.016 | 3.6 | 0.058 |
| Level 1: intercept $e_{0ij}$ | 87.780 | 0.858 | 10476.1 | <0.001 |
| | −2*log(lh) is 153474 | | | |

Reading help for fixed effects

The average general HRQOL score of a boy aged 8 is 56.2 (intercept) with a 95% confidence interval from 54.1 to 58.3. At the age of 8 years, there is no significant difference between the two gender groups; girls have only an average of 0.2 scale points more than boys. With every additional year, the boys' general HRQOL decreases by 1.0 point. The difference in general HRQOL for girls between 8 and 18 years is an additional −0.4 point per year in comparison to boys. Thus, the average change for girls is $\beta_2 + \beta_3 = -1.0 + (-0.4) = -1.4$ for every year of age. In order to calculate the average score of an 18-year-old individual, all significant predictors have to be added up. An 18-year-old boy will have a score of $\beta_0 + (10 \times \beta_2) = 56.2 + (10 \times -1.0) = 46.2$, whereas an 18-year-old girl will have an average score of $\beta_0 + (10 \times (\beta_2 + \beta_3)) = 56.2 + (10 \times -1.4) = 42.2$. The factor ten stands for the 10 years from age 8 to age 18 (see also Fig. 1)

difference between male and female adolescents was observed in the "self" and "physical" scale where meaningful differences were already present from the age of 11 and 12 years, respectively, with *d* ranging from 0.23 to 0.64.

## Discussion

This study bridges a knowledge gap on gender and age differences in HRQOL in Europe. Different aspects of HRQOL were addressed in a comprehensive way. It extends previous research on gender and age differences in HRQOL as it includes both children and adolescents. Thus, diverse results regarding HRQOL in male and female children and adolescents previously found in the literature can be clarified using a new multidimensional instrument and by putting forward a consistent terminology and standardised conceptualisation. Moreover, using multilevel modelling, we could analyse differences in HRQOL across 12 European countries.

The typical pattern of the majority of scales was a decreasing HRQOL score across age groups, which was

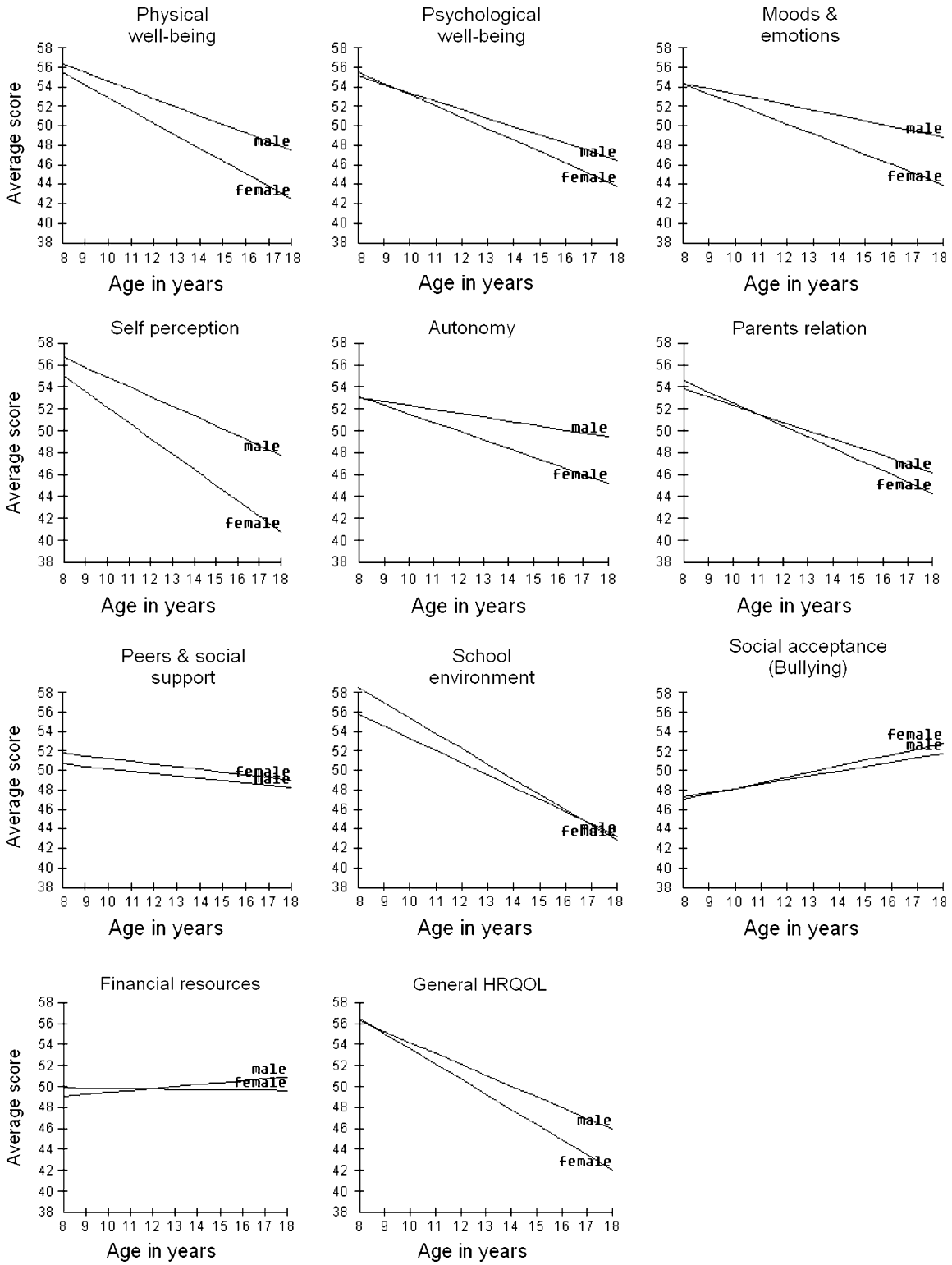


**Fig. 1** Predicted average scores by gender across KIDSCREEN scales ($N = 21{,}590$)

generally more pronounced in female adolescents compared to male adolescents. Most HRQOL scores of 8-year-old boys were similar to the values of girls. However, girls had worse starting conditions from early age on in the "physical" and "self" HRQOL scale. In contrast, for the "parents", "peers", "school", and "financial" aspect of

HRQOL 8-year-old girls showed a significantly better HRQOL score than 8-year-old boys. Male children are often known as the "weaker sex" in literature [25, p. 1], pointing to the higher mortality and morbidity in this population. As our results show, this higher health vulnerability in male children may be evident only partly in some HRQOL aspects. The better starting values for girls aged 8 in the "parents", "school", and "financial" HRQOL scale cannot be maintained; girls showed a more profound decrease in HRQOL with increasing age. Female adolescents are only better off in the "peers" and "bullying/social acceptance" HRQOL aspect. Two of the investigated scales ("financial" and "bullying/social acceptance") differed from the other scales and presented an increasing HRQOL value with increasing age for both genders. Meaningful gender differences occur between the ages of 11 and 14 years and have been observed in the general HRQOL scale as well as in the "moods", "psychological", "self" and "physical" HRQOL scales. The present study could thus confirm all of the specified hypotheses regarding differences between age and gender in HRQOL (Table 1). Though this study was cross-sectional, a recent longitudinal study using a subsample of Spanish children and adolescents showed a decrease in HRQOL over 3 years in most aspects especially in youth aged 10–14 at baseline [26].

The assumption of an age and gender-related HRQOL status is consistent with some psychological theories suggesting that HRQOL decreases gender specifically with increasing age. When adolescents find themselves in puberty, they often encounter problems in coping with their environment [27, 28]. In growing up, they are confronted with a physical and social transition in life and need to adapt to their changing bodies and gender identities [29]. Physiological processes may get out of line through hormonal changes [30]. All this may lead to an impaired HRQOL. Gender differences in HRQOL for children have not been studied so far, although a diversion is reported around the age of 12 years [2]. This finding is supported by the present study showing a stronger gender difference with increasing age. From age 12, female adolescents are in a worse position than male adolescents regarding subjective health and HRQOL. This falls together with the menarche and an imbalance of the hormonal status [30], the prevalence of stressful life events [31], and specific coping mechanisms [32], which may all lead to worse psychological well-being [33–35]. Moreover, studies indicate that women and female adolescents are generally more worried, more concerned with their well-being, and more sensitive, making them more vulnerable to psychosomatic disorders and mental complaints [30, 35, 36]. HRQOL in the "financial" and "bullying/social acceptance" aspect showed an inverted effect with better HRQOL scores for adolescents of both genders. In adolescence, youths are getting independent from parents such that social acceptance may improve as peers become increasingly more important for their own social development in comparison to adults [2, 37]. This more autonomic behaviour in adolescents, which displays the beginning of individuation, may also include the uptake of temporary work in their spare time, thus improving their financial means and financial well-being. Better HRQOL is found in female adolescents with regard to "social acceptance/bullying" and "peers". This finding may be due to the fact that young women and girls differ from their male counterparts in their social relationships and how they are influenced [28, 38, 39]. Studies also suggest that bullying is generally more frequent in childhood than in adolescence [40, 41], a finding that also corresponds with the improved "social acceptance/bullying" HRQOL values in male and female adolescents. Altogether, the present study shows similar results as the pilot study conducted in 2002 [2], when gender and age effects and their interactions have been tested in a similar pilot study. However, the pilot study could only draw on seven countries and did not take the hierarchical structure of the data into account.

HRQOL of children and adolescents differs across European countries, assuming an innate influence of countries' cultural and socio-economic factors on young people's subjective health and well-being. The recently published UNICEF report on child and adolescent well-being in rich countries [42] provides a comparative assessment of 21 European countries regarding six aspects (material well-being, health and safety, educational well-being, family and peers relationships, behaviours and risks, subjective well-being) of child well-being. Their average ranking puts CZ, PL, HU, UK, AT, and FR at the bottom of the table in contrast to NL, ES, CH, and SE where high child well-being was reported. EL and DE are ranked in the middle. Our results of significant variation in HRQOL between countries also point to the importance of the national context for children's and adolescents' well-being and support the argument that "without context health and health-related behaviour can neither be adequately explained nor specifically targeted for improvement" [43, p. 2009]. Future studies are needed in order to explore age and gender differences in HRQOL between different European countries in more detail.

Although the study could profit from a very large sample size with more than 21,000 students, the number of countries is rather small for the use of multilevel analysis. However, we did not have any hypotheses about specific differences between the various European countries regarding the HRQOL in children and adolescents. The use of random effects instead of fixed effects to include the clustering of student in countries, therefore, seemed the valid alternative. Another limitation is certainly the use of cross-sectional data. We cannot rule out that HRQOL in individuals of our sample would have decreased to a lesser

(or larger) extent than suggested in the cross-sectional analysis. However, results from a longitudinal study of a Spanish sub-sample support our results [26].

This study used a large representative sample of European children and adolescents and emphasised the necessity to differentiate among various aspects of HRQOL. It addressed the inconsistent research findings on age and gender differences in HRQOL and showed that among 12 European countries children mostly demonstrate better HRQOL values than adolescents, and that female adolescents often score lower in HRQOL aspects than their male counterparts. Differences in HRQOL between countries point to the importance of national contexts for the health and well-being of children and adolescents.

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